velocity—and like her, they are barely aware of it. I call this kind of training deep practice, and as we'll see, it applies to more than soccer.

The best way to understand the concept of deep practice is to do it. Take a few seconds to look at the following lists; spend the same amount of time on each one.

A	B
ocean / breeze	bread / b_tter
leaf / tree	music / l_rics
sweet / sour	sh_e / sock
movie / actress	phone / bo_k
gasoline / engine	chi_s / salsa
high school / college	pen_il / paper
turkey / stuffing	river / b_at
fruit / vegetable	be_r / wine
computer / chip	television / rad_o
chair / couch	l_nch / dinner

Now turn the page. Without looking, try to remember as many of the word pairs as you can. From which column do you recall more words?

If you're like most people, it won't even be close: you will remember more of the words in column B, the ones that contained fragments. Studies show you'll remember three times as many. It's as if, in those few seconds, your memory skills

suddenly sharpened. If this had been a test, your column B score would have been 300 percent higher.

Your IQ did not increase while you looked at column B. You didn't feel different. You weren't touched by genius (sorry). But when you encountered the words with blank spaces, something both imperceptible and profound happened. You stopped. You stumbled ever so briefly, then figured it out. You experienced a microsecond of struggle, and that microsecond made all the difference. You didn't practice harder when you looked at column B. You practiced deeper.

Another example: let's say you're at a party and you're struggling to remember someone's name. If someone else gives you that name, the odds of your forgetting it again are high. But if you manage to retrieve the name on your own—to fire the signal yourself, as opposed to passively receiving the information—you'll engrave it into your memory. Not because that name is somehow more important, or because your memory improved, but simply because you practiced deeper.

Or let's say you're on an airplane, and for the umpteenth time in your life you watch the cabin steward give that clear, concise one-minute demonstration of how to put on a life vest. ("Slip the vest over your head," the instructions say, "and fasten the two black straps to the front of the vest. Inflate the vest by pulling down on the red tabs.") An hour into the flight, the plane lurches, and the captain's urgent voice comes on the intercom telling passengers to put on their life vests. How quickly could you do it? How do those black straps wrap around? What do the red tabs do again?

Here's an alternate scenario: same airplane flight, but this time instead of observing yet another life jacket demonstration,

you try on the life vest. You pull the yellow plastic over your head, and you fiddle with the tabs and the straps. An hour later the plane lurches, and the captain's voice comes over the intercom. How much faster would you be?

Deep practice is built on a paradox: struggling in certain targeted ways—operating at the edges of your ability, where you make mistakes—makes you smarter. Or to put it a slightly different way, experiences where you're forced to slow down, make errors, and correct them—as you would if you were walking up an ice-covered hill, slipping and stumbling as you go—end up making you swift and graceful without your realizing it.

"We think of effortless performance as desirable, but it's really a terrible way to learn," said Robert Bjork, the man who developed the above examples. Bjork, the chair of psychology at UCLA, has spent most of his life delving into questions of memory and learning. He's a cheerful polymath, equally adept at discussing curves of memory decay or how NBA star Shaquille O'Neal, who is notoriously terrible at shooting free throws, should practice them from odd distances—14 feet and 16 feet, instead of the standard 15 feet. (Bjork's diagnosis: "Shaq needs to develop the ability to modulate his motor programs. Until then he'll keep being awful.")

"Things that appear to be obstacles turn out to be desirable in the long haul," Bjork said. "One real encounter, even for a few seconds, is far more useful than several hundred observations." Bjork cites an experiment by psychologist Henry Roediger at Washington University of St. Louis, where students were divided into two groups to study a natural history text. Group A studied the paper for four sessions. Group B studied only once but was tested three times. A week later both groups were tested, and Group B scored 50 percent

higher than Group A. They'd studied one-fourth as much yet learned far more. (Catherine Fritz, one of Bjork's students, said she applied these ideas to her schoolwork, and raised her GPA by a full point while studying half as much.)

The reason, Bjork explained, resides in the way our brains are built. "We tend to think of our memory as a tape recorder, but that's wrong," he said. "It's a living structure, a scaffold of nearly infinite size. The more we generate impulses, encountering and overcoming difficulties, the more scaffolding we build. The more scaffolding we build, the faster we learn."

When you're practicing deeply, the world's usual rules are suspended. You use time more efficiently. Your small efforts produce big, lasting results. You have positioned yourself at a place of leverage where you can capture failure and turn it into skill. The trick is to choose a goal just beyond your present abilities; to target the struggle. Thrashing blindly doesn't help. Reaching does.

"It's all about finding the sweet spot," Bjork said. "There's an optimal gap between what you know and what you're trying to do. When you find that sweet spot, learning takes off."*

Deep practice is a strange concept for two reasons. The first reason is that it cuts against our intuition about talent. Our intuition tells us that practice relates to talent in the same way that a whetstone relates to a knife: it's vital but useless without a solid blade of so-called natural ability. Deep practice raises an intriguing possibility: that practice might be the way to forge the blade itself.

* Good advertising operates by the same principles of deep practice, increasing learning by placing viewers in the sweet spot at the edge of their capabilities. This is why many successful ads involve some degree of cognitive work, such as the whiskey ad that featured the tag line "... ingle ells, ... ingle ells ... The holidays aren't the same without J&B."

The second reason deep practice is a strange concept is that it takes events that we normally strive to avoid—namely, mistakes—and turns them into skills. To understand how deep practice works, then, it's first useful to consider the unexpected but crucial importance of errors to the learning process. In fact, let's consider an extreme example, which arrives in the form of a question: how do you get good at something when making a mistake has a decent chance of killing you?

Edwin Link's Unusual Device

In the winter of 1934 President Franklin Roosevelt had a problem. Pilots in the U.S. Army Air Corps—by all accounts the military's most skilled, combat-ready airmen—were dying in crashes. On February 23 a pilot drowned when he landed off the New Jersey coast; another was killed when his plane cartwheeled into a Texas ditch. On March 9 four more pilots died when their planes crashed in Florida, Ohio, and Wyoming. The carnage was not caused by a war. The pilots were simply trying to fly through winter storms, delivering the U.S. mail.

The crashes could be traced to a corporate scandal. A recent Senate investigation had exposed a multimillion-dollar price-fixing scheme among the commercial airlines contracted to carry the U.S. mail. President Roosevelt had swiftly responded by canceling the contracts. To take over mail delivery, the president called upon the Air Corps, whose generals were eager to demonstrate their pilots' willingness and bravery. (They also wanted to show Roosevelt that the Air Corps deserved the status of a full military branch, equal to the Army and Navy.) Those generals were mostly right about Air

Corps pilots: they were willing, and they were brave. But in the harsh winter storms of 1934, Air Corps pilots kept crashing. Early on the morning of March 10, after the ninth pilot died in twenty days, FDR summoned General Benjamin Foulois, commander of the Air Corps, to the White House. "General," the president said fiercely, "when are these airmail killings going to stop?"

It was a good question, one that Roosevelt might have directed at the whole enterprise of pilot training. Early pilot training was built on the bedrock belief that good pilots are born, not made. Most programs followed an identical procedure: the instructor would take the prospective student up in the plane and execute a series of loops and rolls. If the student did not get sick, he was deemed to have the capability to become a pilot and, after several weeks of ground school, was gradually allowed to handle the controls. Trainees learned by taxiing, or "penguin-hopping" in stubby-winged crafts, or they flew and hoped. (Lucky Lindy's nickname was well earned.) The system didn't work too well. Early fatality rates at some Army aviation schools approached 25 percent; in 1912 eight of the fourteen U.S. Army pilots died in crashes. By 1934 techniques and technology had been refined but training remained primitive. The Airmail Fiasco, as Roosevelt's problem swiftly became known, raised the question pointedly: was there a better way to learn to fly?

The answer came from an unlikely source: Edwin Albert Link, Jr., the son of a piano and organ maker from Binghamton, New York, who grew up working at his father's factory. Skinny, beak-nosed, and epically stubborn, Link was a tinkerer by nature. When he was sixteen, he fell in love with flying and took a $50 lesson from Sydney Chaplin (half brother of the movie star). "For the better part of that hour we did